Experiment 1: errors, uncertainties and measurements

Experiment 1: Errors, Uncertainties and Measurements Laboratory Report Department of Math and Physics College of Science, University of Santo Tomas Abstract With the use of the ruler, vernier caliper, micrometer caliper and electronic gram scale, the group was able to acquire different sets of measurements by measuring the sphere of unknown composition. The group then was able to compute its mean diameter, average deviation, average deviation of the mean, volume, mass and % percent error for density in SI unit. Then, the members of the group measured the thumb of each other using the ruler and recorded the data in inches. 1. Introduction During the ancient times, there were many types of measurements used but it was highly unreliable. It was during the late 1700s to 1800s when the SI unit was found and it became the standard of measurement. The experiment was designed for studying and analyzing errors and how they occur in an experiment, computing the average deviation, mean and the set of average deviation of the mean, familiarizing and comparing the values produced by the vernier caliper, micrometer and the foot rule, and determining the density of an object given its mass and its volume. 2. Theory In order to prove that no matter how precise your measurements are, there will always be an error. Also, in this experiment, it also aims to prove that the use of body as a tool for measurement will not be precise. 3. Methodology For this experiment, the group used a ruler, vernier caliper, micrometer caliper, electronic gram balance and a sphere of unknown composition. In order to determine the diameter of the sphere, measuring tools such as ruler, vernier caliper and micrometer caliper were used. With the ruler, different angles were used to obtain the diameter of the sphere. With the vernier caliper, the sphere was inserted between its jaws and the screw clamp was closed to prevent the jaws from moving. The diameter of the sphere was determined by the measurement of the main scale added with the measurement of the vernier scale that forms a line with the main scale. [pic] Figure 1: Vernier caliper and its parts With the micrometer caliper, the ball was placed between the anvil and the spindle making sure that the balls was secured in place. Once the ball was secure, the measurements from the main scale and the micrometer scale where then added to get the diameter of the sphere. [pic] Fig 2. Micrometer Caliper and its parts Ten trials were done for each of the measuring instruments. When the data was complete, the following values were computed: Average Diameter, Average Deviation, Average Deviation of the Mean, Volume, Experimental Value of Density and the Percent Error of Density. 4. Results and Discussion Figure 1: Using foot rule | Diameter of Sphere (cm) | | Trial | Measurement | Difference from Average | | | of Diameter | Deviation | | 1 | 1. 90 cm | 0. 06 | | 2 | 1. 80 cm | 0. 04 | | 3 | 1. 85 cm | 0. 01 | | 4 | 1. 80 cm | 0. 04 | | 5 | 1. 90 cm | 0. 06 | | 6 | 1. 80 cm | 0. 04 | | 7 | 1. 85 cm | 0. 01 | | 8 | 1. 82 cm | 0. 02 | | 9 | 1. 83 cm | 0. 01 | | 10 | 1. 82 cm | 0. 02 | | Mean Diameter | 1. 84 | 0. 03 | | Average Deviation(a. d.) | 0. 003 | | Average Deviation of the Mean (A. D.) | 0. 0003 | | Volume (cm³) | 3. 262 cm³ | | Mass (g) | 28. 01 g | | Experimental Value of Density (g/cm³) | 8. 59 g/cm³ | | Accepted Value of Density(g/cm³) | 7. 8 g/cm³ | |% Error for Density | 10. 12% | Figure 2: Using Vernier Caliper | Diameter of Sphere (cm) | | Trial | Measurement | Difference from Average | | | of Diameter | Deviation | | 1 | 1. 90 cm | 0. 06 | | 2 | 1. 90 cm | 0. 04 | | 3 | 1. 90 cm | 0. 01 | | 4 | 1. 90 cm | 0. 04 | | 5 | 1. 90 cm | 0. 06 | | 6 | 1. 90 cm | 0. 04 | | 7 | 1. 90 cm | 0. 01 | | 8 | 1. 90 cm | 0. 02 | | 9 | 1. 90 cm | 0. 01 | | 10 | 1. 90 cm | 0. 02 | | Mean Diameter | 1. 90 | 0. 03 | | Average Deviation(a. d.) | 0 | | Average Deviation of the Mean (A. D.) | 0 | | Volume (cm³) | 3. 592 cm³ | | Mass (g) | 28. 01 g | | Experimental Value of Density (g/cm³) | 7. 79 g/cm³ | | Accepted Value of Density(g/cm³) | 7. 8 g/cm³ | |% Error for Density | 0. 128% | Figure 3: Using Micrometer Caliper | Diameter of Sphere (cm) | | Trial | Measurement | Difference from Average | | | of Diameter | Deviation | | 1 | 1. 9000 cm | 0. 0094 | | 2 | 1. 9440 cm | 0. 0346 | | 3 | 1. 8811 cm | 0. 0283 | | 4 | 1. 9005 cm | 0. 0089 | | 5 | 1. 9015 cm | 0. 0079 | | 6 | 1. 9491 cm | 0. 0397 | | 7 | 1. 8920 cm | 0. 9740 | | 8 | 1. 8930 cm | 0. 0164 | | 9 | 1. 8870 cm | 0. 0224 | | 10 | 1. 9458 cm | 0. 0364 | | Mean Diameter | 1. 9094 | 0. 2214 | | Average Deviation(a. d.) | 0. 002214 | | Average Deviation of the Mean (A. D.) | 0. 0002214 | | Volume (cm³) | 3. 645 cm³ | | Mass (g) | 28. 01 g | | Experimental Value of Density (g/cm³) | 7. 68 g/cm³ | | Accepted Value of Density(g/cm³) | 7. 8 g/cm³ | |% Error for Density | 1. 54% | The measurement accuracy becomes smaller as the decimal value of the measuring tool becomes lower. However, based on Figure 1, Figure 2 and Figure 3, the % Error for density was acceptable if compared to Figure 1, but the % Error for density of Figure 2 and Figure 3 are compared, the value of Figure 2 is much accurate as compared to Figure 3. This can be attributed to various sources of error like misreading of the person, tightly or loosely lock of vernier caliper and micrometer caliper, rounding off in-between calculations, and many more. Figure 4 | Group Member | Dy | Ferrer | Gabaton | | Width of Thumb (in) | 1. 25 in | 1. 20 in | 1. 25 in | The thumb of a person which was measured using a thumb in inches differentiates from one person to another. It is because of the fact that people have specific physical characteristics that are different from one person to another. 5. Conclusion After conducting the experiment, the experiment shows that the Vernier Caliper is the most accurate tool of measurement among the three because it exhibited the lowest Percent Error. Some possible causes of error, for the foot rule would be the inconsistency of the person reading the measurement. And for the Micrometer Caliper, it would be how tight or how loose one adjusts the barrel. 6. Application Among the three devices, the micrometer caliper gives you the least & error since the micrometer caliper gives the data up to the thousandth digit. Errors are sure to occur especially if the data computed does not have a basis since by definition; error is a deviation from something correct. Because of this, the data must be precise as possible. If there is an occurrence of random errors, increasing the trials is recommended to minimize errors. If there is an occurrence of systematic errors, recheck your equations. Until now, most people use parts of the body as an estimate on how to measure certain objects like the thumb to use as an inch, a yard to measure the stretch of the hand up to the other direction of the shoulder, and many more. It is an estimate because it the value it produces differs significantly from one person to another. 7. References Taylor, John R. An Introduction to Error Analysis: The Study of Uncertainties if Physical Measurements. University Science Books, 1982. (http://teacher. nsrl. rochester. edu: 8080/phy_labs/AppendixB/AppendixB. html) P. V. Bork, H. Grote, D. Notz, M. Regler. Data Analysis Techniques in High Energy Physics Experiments. Cambridge University Press, 1993. (http://teacher. nsrl. rochester. edu: 8080/phy_labs/AppendixB/AppendixB. html) ----------------------- a. d = £d n £d = mean diameter Where: d = diameter of the sphere n = number of trials a. d. = average deviation A. D. = average deviation of the mean v = volume of sphere r = radius E = Experimental Value of Density S = Accepted Value of DenÎ£d n Î£d = mean diameter Where: d = diameter of the sphere n =

number of trials a. d. = average deviation A. D. = average deviation of the mean v = volume of sphere r = radius E = Experimental Value of Density S = Accepted Value of Density A. D. = a. d. âˆšn V = 4/3 Ï€r^3 Î¡ = mass Ã· volume % Error = (E-S) Ã· S*100